

Infrared Spectroscopy of Ruthenium Tetroxide and High-resolution analysis of the v3 band

S. Reymond-Laruinaz, D. Doizi, L. Manceron, V. Boudon, G. Ducros

▶ **To cite this version:**

S. Reymond-Laruinaz, D. Doizi, L. Manceron, V. Boudon, G. Ducros. Infrared Spectroscopy of Ruthenium Tetroxide and High-resolution analysis of the v3 band. HRMS 2015 - The 24th Colloquium on High Resolution Molecular Spectroscopy, Aug 2015, Dijon, France. cea-02489554

HAL Id: cea-02489554
https://cea.hal.science/cea-02489554

Submitted on 24 Feb 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

INFRARED SPECTROSCOPY OF RUTHENIUM TETROXIDE AND HIGH-RESOLUTION ANALYSIS OF THE ν_3 BAND

S. Reymond-Laruinaz[1]; D. Doizi[1]; L. Manceron[2]; V. Boudon[3]; G. Ducros[4]

[1]CEA, DEN, Département de Physico-chimie, CEA/Saclay, 91191 Gif sur Yvette Cedex, France.
[2]Société Civile Synchrotron SOLEIL, L'Orme des Merisiers, St-Aubin BP48, 91192 Gif-sur-Yvette Cedex, France.
[3]ICB, UMR 6303 CNRS-Université de Bourgogne, 9 avenue Alain Savary, BP 47870, F-21078 Dijon Cedex, France

INTRODUCTION

After the Fukushima accident, it became essential to have a way to monitor in real time the evolution of a nuclear reactor during a severe accident, in order to react efficiently and minimize the industrial, ecological and health consequences of the accident. Ruthenium is a low volatile fission product but in case of the rupture of the vessel lower head by the molten corium, the air entering into the vessel oxidizes Ru into a gaseous form: RuO_4. To monitor the presence of RuO_4 allows making a diagnosis of the core degradation and quantifying the potential release into the atmosphere. RuO_4 is of prime importance since it can have a significant radiological impact. Here, we present the study of the feasibility of the monitoring by an optical measurement.

MATERIAL AND METHODS

RuO_4 is very reactive: Requires a synthesis and analytical process fully passivated.

Synthesis process

- Alkaline fusion of Ruthenium metal with potassium hydroxide
- Oxidation with potassium permanganate
- Trapping RuO_4 gas in dry ice

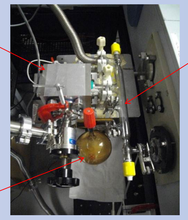
Measuring system

Measuring cell and specific pressure sensors, fully passivated.

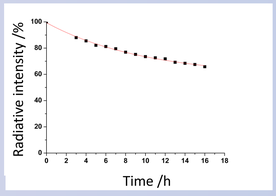
- Glass cell (124 mm)
- ZnSe windows treated AR reflexion
- Kalrez seals and teflon valves
- Pressure sensors developed at the French SOLEIL synchrotron facility (L. Lago)
- whose surfaces exposed to the gas were passivated (res: 0.02 mbar)





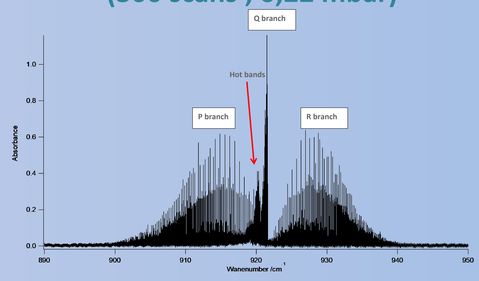


BUT **RuO_4 ν_3 intensity decreases over time**

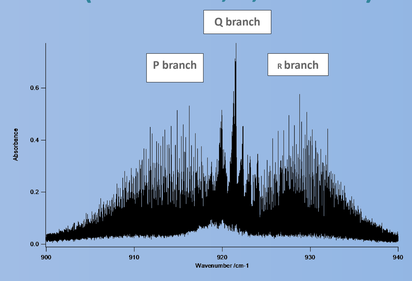


➢ Analysis by high resolution FTIR spectroscopy (SOLEIL synchrotron, AILES beamline)

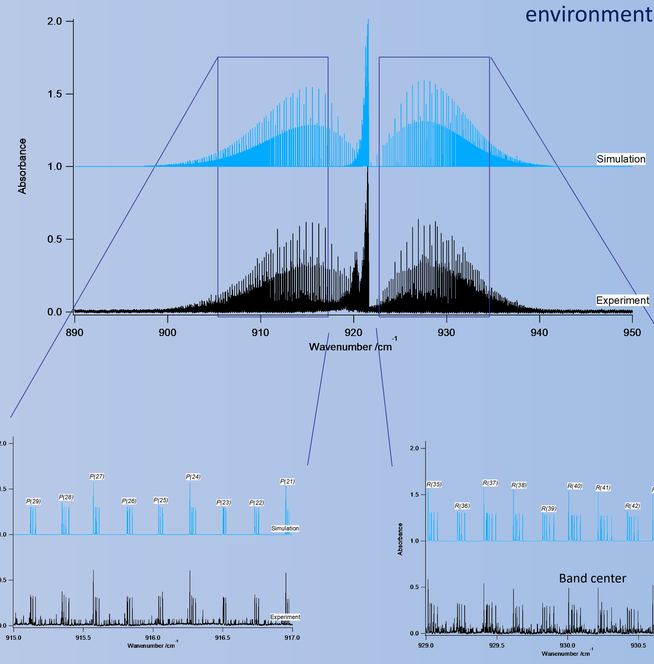
$^{102}RuO_4$ monoisotopic (300 scans ; 0,22 mbar)

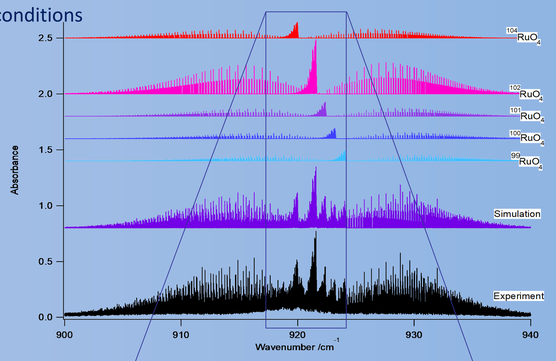


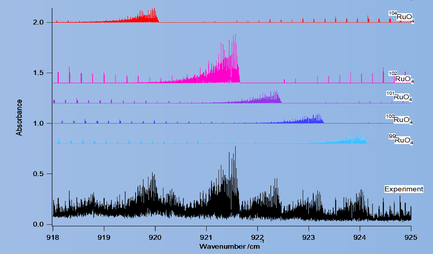
RuO_4 in natural abundance (680 scans ; 0,72 mbar)



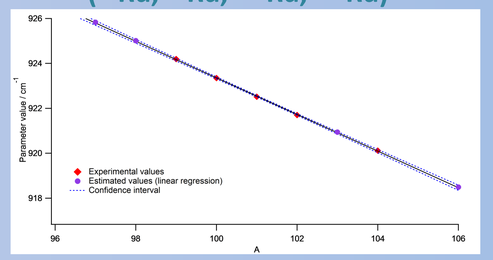
➢ Simulation by tensorial formalism (XTDS, SPVIEW) => Reference spectra whatever the environmental conditions



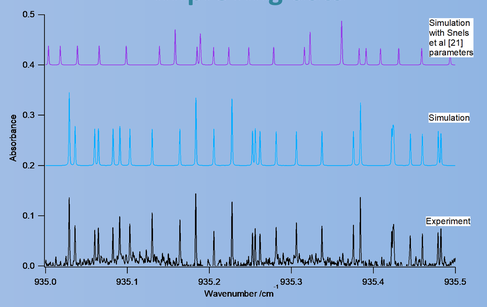




Extrapolation of parameters for minor isotopologues (^{97}Ru, ^{98}Ru, ^{103}Ru, ^{106}Ru)



Improving data



PERSPECTIVES

⇒ Analysis by high-resolution Raman spectroscopy to determine the parameters of the ν_1 vibration mode (In progress)
⇒ An analysis by high-resolution in the far infrared, to study the ν_2/ν_4 bending dyad (In preparation)
- The determination of the ν_1, ν_2, ν_3 and ν_4 harmonic wavenumbers values => RuO_4 equilibrium bond length.
- It would allow the study of higher harmonics of the RuO_4 bending modes.
- It would allow the identification of weak forbidden lines that permit to fit ground state parameters.

⇒ Determination of the spectral broadening: Simulation of RuO_4 dilute in the air: quantification of the release
⇒ Development of a new sensor based on an optical measurement (LIDAR, CES,….)

S. Reymond-Laruinaz, V. Boudon, L. Manceron, L. Lago and D. Doizi, *Journal of Molecular Spectroscopy, doi:10.1016/j.jms.2015.02.008 (2015)*